

Computational bioacoustics with deep learning: a review and roadmap

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Abstract

Animal vocalisations and natural soundscapes are fascinating objects of study, and contain valuable evidence about animal behaviours, populations and ecosystems. They are studied in bioacoustics and ecoacoustics, with signal processing and analysis an important component. Computational bioacoustics has accelerated in recent decades due to the growth of affordable digital sound recording devices, and to huge progress in informatics such as big data, signal processing and machine learning. Methods are inherited from the wider field of deep learning, including speech and image processing. However, the tasks, demands and data characteristics are often different from those addressed in speech or music analysis. There remain unsolved problems, and tasks for which evidence is surely present in many acoustic signals, but not yet realised. In this paper I perform a review of the state of the art in deep learning for computational bioacoustics, aiming to clarify key concepts and identify and analyse knowledge gaps. Based on this, I offer a subjective but principled roadmap for computational bioacoustics with deep learning: topics that the community should aim to address, in order to make the most of future developments in AI and informatics, and to use audio data in answering zoological and ecological questions.